Compressed Air

DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

VOL. I. NEW YORK, DECEMBER, 1896. No. 10

STUDY WITH AN AIR BRUSH.

A MONTHLY PUBLICATION DEVOTED TO THE USEFUL APPLICATION OF COMPRESSED AIR.

W. L. SAUNDERS, - - - Editor and Publisher
A. E. KENNEY, - - - Managing Editor
J. E. QUINTERO, } - - - - - Associates
F. C. WEBER, }

Subscription, including postage, United States, Canada and Mexico $1.00 a year. All other countries, $1.50 a year. Single copies, 10 cents.

Advertising rates furnished on application.

We invite correspondence from engineers, contractors, inventors and others interested in compressed air.

All communications should be addressed to COMPRESSED AIR, 26 Cortlandt St., New York.

London Office, 114a Queen Victoria Street.

Those who fail to receive papers promptly will please notify us at once.

Entered as Second-Class Matter at the New York, N. Y., Post Office.

VOL. I. DECEMBER, 1896. NO. 10.

An evidence of the growing interest taken in compressed air was noticed at the recent monthly meeting of the New York Railroad Club, held in the rooms of the American Society of Mechanical Engineers in New York city. A paper was presented at that meeting by Mr. Shields, in which compressed air and its application to railroad shops was discussed. The attendance at the meeting was exceptionally large; perhaps the largest held since the organization of the Club. The discussion of the subject was so general that it was found necessary to close the meeting on account of the lateness of the hour, before the subject had been exhausted. It is likely that there will be a continuation of the discussion at a subsequent meeting.

Railroads have been quite active of late in developing compressed air apparatus. There is no particular reason why railroad shops should use compressed air to any better advantage than machine shops and foundries in general. If compressed air is a good thing in railroad shops, the same reasons that make it so apply to other shops. That it is a good thing, and that its use is growing, no one doubts. Its advantages and the saving that is effected by its use are now established facts. Some of the figures representing this saving were given at the meeting. In looking for the reasons why railroads have been pioneers in this line, we turn to the air pump used on locomotives. This pump, or compressor, had done such good work for years, and has become so familiar to the master mechanic that it turned attention to compressed air power. The simplicity of the apparatus, the ease with which it was cared for and understood by mechanics, and the apparent applicability of the air to so many different purposes, led to developments in this line.

An old locomotive sent to the shop for repairs was immediately robbed of its air pump, which was bolted against the wall of the shop and put into use, serving a useful purpose in helping to repair the engine. Shops in this way became equipped with a number of air pumps, until it was apparent that an air compressor properly designed for economic production of compressed air should have a permanent place in the establishment.

All this bears out the view which we have always taken of this subject; that is, that the use of compressed air has not grown as rapidly as it should, because it is not understood. It is looked upon as too much of a mystery, and the idea has existed in the minds of men that at best it is an expensive power to produce. A little experience with it convinces the most incredulous that it is not an expensive power either to produce or use, nor is its use dangerous as some suppose; on the contrary, there is no power so humane. There is certainly nothing explosive about air itself.

When confined in a weak vessel it may create a disturbance, but there is no occasion for the use of weak vessels in either steam or compressed air. It is evident that an explosion in a steam vessel is more likely to produce hurtful results than if the same vessel were filled with air. Not only is the scalding effect from steam objectionable, but there is usually a confined body of superheated water held down by the steam and always ready to expand into hot steam globules as soon as there is a release of pressure. This means a large reserve force which under usual conditions surrounding explosions will result in a damage more serious than any likely to occur or hardly possible with compressed air.

Compressed Air Central Plants.

The enthusiasm and ingenuity being displayed in the application of compressed air for power purposes will no doubt bring to light many schemes for further advancing its use, now that it is in a fair way to be adopted in so many places where a few months ago it would have been rejected—not for the reason that it was not competent, but because it seemed new and untried. Many of these dormant schemes will be brought out and the fortunate inventor will reap a long delayed reward.

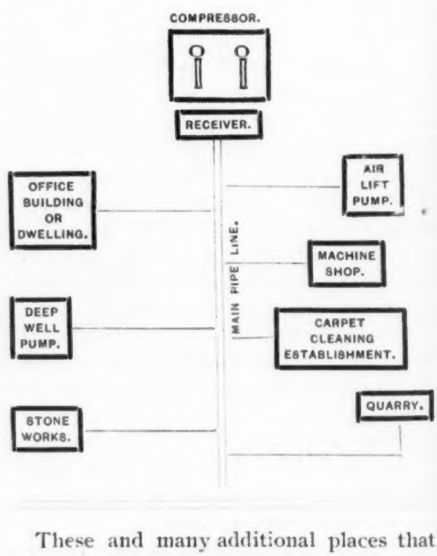
For transmission of power, compressed air perhaps has no equal. It is always ready, willing, and obedient. There does not seem to exist any of the dangerous elements that are associated with other forces. Already the central plant idea is taking possession of the minds of the mechanical genius of the world, and a few of the many devices that may be operated from central plants will be of interest to engineers in general, and will stimulate the adoption of compressed air in many places where it is not now applied. We have already told of the successful and highly economical operation of various appliances at Jerome Park, New York. It is simply a gigantic exhibition of the cooperative system in mechanics, where the judicious distribution of power effects good results and accelerates the completion of necessary work.

A proposition has been made wherein one air compressor will supply power to run several pumps that are widely separated, for pumping sewage to a level of the sewer line in the city of Chicago.

It seems in this case numerous steam-actuated pumps were to be employed, each one of which would require a boiler and an attendant to operate it. A progressive firm of pump manufacturers now propose to erect a central air power plant, lay the pipe line to each pump and operate it by air instead of steam, and chances are that they will win the contract.

These two instances are only given to illustrate the importance to be attached to this method.

This little diagram will serve to illustrate the outlines of a central plant and its tributaries :



These and many additional places that may be added could readily be run from

the one compressor plant, as they may all be within a half mile of each other.

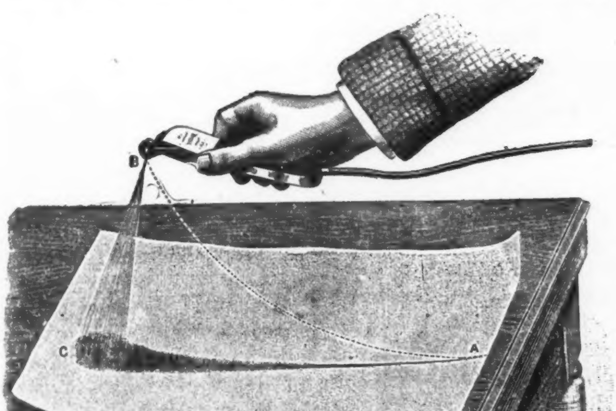
As to the feasibility of this plan, there is no doubt. It has been demonstrated, time and again, that by using compressed air for the purposes for which it may be employed you will enjoy several advantages over steam and electric power. First of all comes safety and cleanliness, then reliability, and the simplicity with which it may be handled and made to do man's bidding. The cost is always dependent upon conditions; but in any case that we can think of it will be as cheap as either of the two agents mentioned, and if water power is available it will be much cheaper than either of the others.

THE AIR BRUSH.

COMPRESSED AIR greets its readers by the reproduction in half tone of a "human eye" which was drawn by what is known as the Air Brush. Unfortunately the process of engraving fails to bring out the delicate softness that appears in the original; still, it gives an idea of an extremely beautiful production by means of compressed air.

The air brush is a device for applying liquid color by a jet of air. It consists of three parts—air pump, air receiver, and hand piece, connected by the necessary rubber tubing. The distribution of color is entirely controlled by the thumb-valve, and the artist can produce the finest line or instantly change to a broad shadow. These effects with a single stroke have a finish that only hours of toil can equal by other means.

The cut below will give a clear idea of the action of the brush. It will be seen that holding the instrument near the surface produces fine lines, that by elevating the instrument broad effects are produced, and that the artist can go from line to shadow without stopping, as seen in the cut. Supposing the instrument moved from A to B, following dotted lines, the effect would be as seen on the paper from A to C. The increased supply of liquid necessary to produce the broad effect at C, is regulated entirely by the thumb.



The Air Brush is as yet in its infancy. Its growth has been slow on account of its novelty. Entering upon a field where never before had anything been substituted for the old method, some avoided it

because of its novelty, or the fear that they would lose their individuality and be termed machine workers by others of their profession. Thanks to the young artists who are growing up to-day to take the place of the old, they have looked into this modern method of picture making and have not found it wanting. They use the Air Brush, and are making pictures with a better finish and in less time than their predecessors ever dared dream of.

Its use at the present day is largely confined to portrait artists. It has a place in every branch of art where delicate shading is needed. It is used successfully by lithographers, designers, monumental men, architects, etc., etc.

The Air Brush handles all liquid colors; distributes on any surface; is used in coloring maps, geological surveys, in silk, china, and porcelain decorations, colored glass work, on albumen, bromide, solar, platinum, and electric light prints, and largely in finishing sketches.

At present there are eight Compressed Air Cars running on the New York street railways, and we look to see the number grow.

The Use of Compressed Air at a Blast Furnace Plant.

When "A" Furnace of the Maryland Steel Co., Sparrow's Point, Md., was blown in for its second blast (November, 1895), a compressed air plant was put in, and has been used with much success during the past year. Compressed air is used for the tap-hole drill, the tap-hole "gun," the transfer-table at the scales, the turntable on top of the furnace, and for lifting the rails of the turntable in running off the empty cars.

The compressor (a Rand direct-acting steam air compressor) and the receiver are set up in the pump-house, and are cared for by the pump man. The air-pipe from the receiver to the furnace is about 500 feet long; there the pipe branches to the different machines. Last winter the air first passed through a coiled pipe heated by a coke fire near the scales, in order to keep the moisture in the condensed air from freezing. The piping at the furnace is so arranged that steam can be used for all the machines in case the compressor breaks down, and on the transfer-table hydraulic pressure also can be used. The pipes and valves are so arranged that air or steam can be used on any or all the machines, and so that all the pressure can be put on any one machine.

The tap-hole drill is a Little Giant rock drill so mounted as to swing into place and drill out the tap-hole without any hard manual labor. This arrangement is the device of Superintendent David Baker, and is described by him in Trans. Amer. Inst. Min. Eng., vol. xxi. The supporting crane has been much changed since that description was written, and now consists of the simple and light crane shown in the photograph. The crane is fastened to one of the columns at the side of the tap-hole so that the drill can be swung back out of the way when not in use. The air-pipe is connected by swing joints and an expansion sleeve, which can be seen in the photo-

graph (the drill is in place ready to open the hole, the "gun" is loaded and ready to swing into place).

Formerly steam was used to run the drill, but it has several disadvantages which air has not. Great care had to be taken to prevent the condensed steam from dripping into the iron trough and perhaps causing a "boil." The escaping steam would make it hot for the men, and the clouds of vapor would often prevent them from watching the work well. A hose for the exhaust was necessary, and this made another part to care for, and it was sometimes burned. In cold weather there would be much condensing and loss of power. Compressed air does away with all these difficulties.

The tap-hole "gun" is Mr. S. W. Vaughen's patent device for shutting the tap-hole by power, thus saving much hard, hot work for the men, and doing away with the necessity of taking the blast off the furnace after each cast to shut the tap-hole.

An illustrated description of an early form of this gun is given in the "Iron Age," Nov. 21, 1895. The gun shown in Figs. 1 and 2 has a "breech" for loading, a compact valve, and a simple and adjustable mounting. It is made of cast iron and consists of two cylinders and a piston rod with a piston on each end. The air end of the gun is an ordinary air-cylinder operated by a hand valve. The clay "barrel" is open at the "nose" end, and has a "breech" at the other end (see Fig. 2). The gun is suspended on a crane fastened to the column opposite the drill. The crane is similar to the drill crane, and the air-pipe has swing joints and a rubber hose connection to allow freedom of motion.

The gun is loaded with about 35 clay balls before the cast, and when the iron is all out of the furnace the gun is swung around and clamped into place and the whole charge shot into the tap-hole at once. By reversing the valve the piston is brought back; the breech is opened, the clay barrel loaded up again and more clay shot into the hole till it is completely shut up.

FIG. 1.

Here the air has the same advantages over steam as in the drill. About 65 to 70 pounds air pressure is needed for the drill and gun. If at any time there is not enough pressure to run the drill well, a signal is given from the furnace to the pumpman, and he sets the escape valve of the receiver for higher pressure.

In order to have rapid handling of the ore, limestone, and coke, buggies which have four wheels, run on tracks, and hold from 1500 to 2300 lbs. of stock, at the

scales, a transfer table is placed between the scales and the elevator. When the empties come down they are run off from the elevator onto the transfer which is run to one side; then the loaded cars on the scales are pushed across the transfer, which is provided with seven sets of rails running crosswise, onto the cage of the elevator. This transfer is operated by compressed air, and is provided with water cushions at either end to permit rapid running and to take up the shock. At present the compressed air is obtained from the regular blast main of the furnace, which averages 10 or 12 lbs. pressure. When the blast is off the furnace, hydraulic pressure of 26 lbs. is used in the same cylinder, but it is too slow for regular work. At first the transfer was run by air at 60 to 70 lbs. pressure from the compressor, using a smaller cylinder which can now be used in case of any break-down of other parts.

The turn-table on top is a part of the filling arrangement necessary to give an even distribution of the stock as it is dumped into the furnace. It has a track on each side holding two buggies at once, so that two buggies are dumped on one side, and the next two buggies on the other side. On every other "charge" the turn-table with the loaded buggies on it is turned about 75 degrees, and then the stock is dumped. Air from the compressor is used for this table, and has proved more suitable than steam, especially in cold weather.

The two tracks which extend across the turn-table are arranged so that the back ends can be raised by pistons working in compressed air cylinders. When the ore is dumped the rails are raised, and the empty buggies run back onto the cage with a little help from the men. Air from the compressor runs these lifts also.

The blacksmith's forge, in a shop near the pump-house, is ordinarily run by blast from the furnace blowing engine; but if the furnace is stopped for any reason, blast for the forge can be taken from the receiver of the air-plant.

Thus the air compressor has become a valuable machine at the furnace.

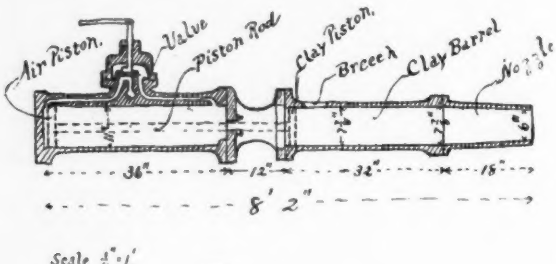


Fig. 2.

The trouble from condensed moisture in the different machines was largely due, I think, from the fact that the compressor takes its air directly from the pump-room which is always warm and moist. I here suggest that much better work would be done if the air were taken directly from outdoors.

RALPH H. SWEETSER.

Our account in last month's issue of the test of the Mannesmann tube for the storage of Compressed Air for street cars, should set at rest any doubt, and allay any fear of danger of the bursting of these vessels.

COMPRESSED AIR.

(CONTINUED.)

Mr. Sturgeon, of England, has applied a most ingenious and successful inlet valve, which is opened and closed by the friction of the air piston rod through the gland. Mr. Sergeant in America has introduced the piston inlet valve, which is opened and closed by its own inertia. We have, therefore, reached a point at which high speed is made possible.

In the single or straight line compressor it is difficult to equalize power and resistance with long strokes. The speed will be jerky, and when slow the fly wheel rather retards than assists in the work of compression. This action tends to derange the parts and makes large bearings a necessity. The piston in a long stroke compressor travels through considerable space before the pressure reaches a point where the discharge valve opens, and after reaching that point it has to go on still further against a prolonged uniform resistance. This makes rotative speed difficult in single direct acting machines. During the early part of the stroke, the energy of the steam piston must be stored up in the moving parts, to be given out when the steam pressure has been reduced through an early cut-off. With a short stroke and a large diameter of steam cylinder we are able to get steam economy or early cut-off and expansion without compounding.

In compressors of the single or direct acting type with steam and air cylinders of equal diameter it is possible to obtain a pressure of air twice as great as the boiler pressure. This apparent enigma is made plain when it is understood that at the beginning of the stroke there is no resistance in the air cylinder. The steam end at this point has its greatest power, and the supply may be cut-off and the steam expanded in proportion to the pressure required in the air end, and the speed of the machine. The indicator card shows a large volume and low pressure in the steam end, and a smaller volume and higher pressure in the air end, so that what is made up in the air card by high pressure is represented in the steam card by greater volume, and the area of one is nearly equal to that of the other. This can be seen by referring to Fig. 11.

If we omit the cut-off on the steam end the pressure, instead of following the dotted lines, will be maintained at its maximum throughout the stroke, while the air pressure, or resistance, does not reach the steam pressure until the piston has passed the centre of the cylinder; hence if there is sufficient inertia in the moving parts, there will be no difficulty in getting an air pressure higher than that of the steam.

CLEARANCE.

The early designers of air compressors, as shown in the Dubois & Francois illustrations (Figs. 8 and 9), mention clearance loss in air compressors as a very serious matter. Even at the present time some air compressor manufacturers admit water through the inlet valves into the air cylinder, not so much for the purpose of cooling as to fill up the clearance spaces. A long stroke involving expensive construction is sometimes justified by the claim that a saving is effected by reduced clearance losses.

Clearance in a properly designed compressor is a loss of volume only, not a loss of power. Let us assume, for the sake of illustration, that we are compressing air with a machine which is provided with so efficient a cooling device that all of the heat of compression will be absorbed as soon as produced. In other words, that we can compress air isothermally. In such a machine as this there will be a slight loss of power due to clearance space, because we would have a certain volume of air in the cylinder at each stroke, and upon which work had been done and heat pro-

duced, that heat having been absorbed and the air being retained in the cylinder. In other words, we would have a production and abstraction of heat, which would represent power lost. Isothermal compression is practically impossible; hence we do not abstract the heat from the compressed air in the clearance space, but a large portion of this heat remains, and acts expansively upon the air, imparting its power to the piston at the moment of reversal of stroke. A reasonable clearance space behind the air piston serves a useful purpose in overcoming the inertia of the piston and moving parts acting like a spring at the end of each stroke.

The clearance space in modern air compressors of the best design (including the counter-bore and discharge valve clearance) varies from .002 to .0094 of the volume of free air furnished by the cylinder. The variation is somewhat dependent upon the length of stroke of the machine. At 75 lbs. pressure, and making due allowance for increased volume of air due to heat, the clearance loss of volume varies from .01 to .047, or from one to five per cent. of the air when compressed. The actual space between the piston and the head at the end of the stroke being 1-16″.

It must not be inferred that the designers of an air compressor may neglect the question of clearance; on the contrary, it is a very important consideration. If we have a large clearance space in the end of an air compressor which is used to compress air to high pressures, we may readily understand a condition of things that would result in no discharge of compressed air at all, because of too large a clearance space. The entire volume of the cylinder might be compressed and retained in the clearance space, and the compressor will take in no free air on the return stroke, because the clearance space air when expanded is sufficient to fill the cylinder at normal or atmospheric pressure.

Loss in capacity of air compressors by clearance is in direct proportion to the pressure.

Owing to the loss of capacity by clearance in high pressure compressors, it is important that the cylinders be compounded. By compounding the air in the cylinders the clearance loss is reduced because of the reduced density in the air in the clearance space.

Builders of air compressors employ three methods to reduce the clearance loss: (1), By long strokes of piston, so that the percentage of cylinder volume to that of clearance space is reduced to a minimum. (2), By filling the space with water. (3), By not allowing the full reservoir pressure to accumulate in the clearance space above the inlet valve.

The long stroke plan is the best for reducing clearance, except in machines of the single type, where economical compression and rotative speed cannot be accomplished with a long stroke. The use of water to fill clearance spaces has been referred to previously when treating of water injection.

The clearance in the initial cylinder is filled with air at a pressure less than the receiver pressure; and as the diameter of the high pressure cylinder is small, the loss in capacity by clearance is reduced. Mr. E. Hill states that a single type of compressor should have a stroke of 68 in., in order that its clearance loss shall not exceed that of a compound compressor of 24 in. stroke when both compressors are forcing air against 60 pounds pressure.

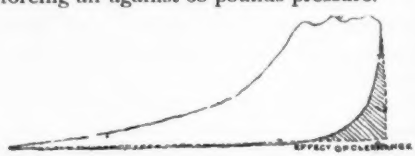


Fig. 15.

Fig. 15 illustrates the effect of clearance in loss of volume in an air compressor. The diagram illustrates a typical case in

compressors of cheap design and manufacture, the loss in volume amounting to about 20 per cent.

Unnecessary complications have been applied to air compressors to overcome clearance loss. Mr. Sturgeon has designed an air cylinder with lifting heads, so that the piston slightly raised the head at each stroke, thus reducing clearance to an exceedingly small figure.

A simple method of reducing the clearance loss is by a passage or by-pass grooves in the end of the cylinder arranged in such a way that when the piston reaches the end of the stroke it passes over the grooves and thus allows the high pressure air, which is confined in the clearance space, to pass to the other side of the piston. The air in such cases is usually allowed to pass through the grooves at a velocity not exceeding 100 ft. per second. This plan is, however, subject to objections, and it is doubtful that there is anything gained by it. The load on the air piston is suddenly removed when the grooves are uncovered, and thus the cushion behind the piston is destroyed, and unless the cushion in the steam end is effective the compressor will pound badly at the end of each stroke.

The commonest form of inlet valve applied to air compressors is the poppet. It is plain that as soon as the piston starts from the extreme point of stroke nearest the cylinder head, it is followed by the air confined in the clearance space until that point is reached when the pressure in the cylinder is equal to the pressure outside. From this point the action of the piston is now to produce a partial vacuum within the cylinder, resulting in opening the poppet inlet valves against the tension of the spring which holds them to their seats. The result of all this is that the poppet valve construction does not admit of a full air cylinder, as no air from the outside is admitted during a portion of the stroke. Even after the inlet valves are opened there is more or less friction through the passages which reduces the atmospheric pressure. There is seldom less than one pound per square inch difference in pressure between the air within and without the cylinder. This, though apparently small, results in a very serious reduction of efficiency.

A common defect in air compressor construction is insufficient space for proper delivery after compression. The discharge valves and discharge passages are so contracted as to offer considerable resistance to the passage of the air which should be discharged at the same velocity as that at which the piston moves. As the area in the cylinder head is usually small, the volume of valve area is restricted to the minimum. Heavy springs are used in order to prevent the valves from hammering, and the result of this is a loss of power. It is not a difficult matter to admit the air through a valve which is moved by direct mechanical connection, and without springs, but many difficulties are in the way of positive movement in discharge valves. The exact point when it is desired to admit the air is fixed for all pressures and temperatures, but not so with the point of discharge. This varies in proportion to the pressure, and this is effected more or less by the conditions of temperature, dryness and density of inlet air, and the cooling effect during compression. It would not do to hold the discharge valves closed after the pressure in the cylinder has reached the point of pressure in the receiver. Equally serious in loss of efficency would it be to open a discharge valve before the air in the cylinder has reached the receiver pressure; hence the poppet form of discharge valve is generally used.

Designers of air compressors seldom consider the velocity at which the compressed air is discharged from the cylinder. When the discharge valves are first opened the piston is moving with considerable velocity, which discharges the air in some cases at a velocity of 200 ft. per sec-

ond. This is, of course, gradually reduced as the piston nears the end of the stroke.

Poppet valves when used either for inlet or discharge should be small in diameter and light in weight. Various designs involving poppet valves of large diameter have been applied to compressors, but they have invariably failed because the increased inertia of a large valve will pound the seats and break the springs. Where poppet valves are used, a large number of small, light valves is the best construction. The movement of a poppet valve should be as short as possible, in order to minimize the wear which results from constantly striking the seat.

It is important in designing an air compressor to provide ample inlet space, so that the cylinder will be filled with air and thus maintain the full volumetric capacity of the machine. The usual area of inlet is 1-10, the area of the piston, though in slow speed compressors this might be reduced considerably. Compressors provided with a concentrated inlet through which the air is drawn alternately at one end and the other of the piston, do not require as large an area of inlet as the intermittent type, because the air when once started through the inlet is maintained constantly moving in one direction and toward the cylinder; thus a draft of air is produced which materially aids in piling up the pressure at the point of reversal of stroke. It must be borne in mind that while the piston is drawing the air into the cylinder its speed is variable. At the beginning, when turning the centre, it is slow, increasing rapidly until it reaches its maximum speed at the centre, of the stroke and then decreasing until it reaches the point when the inlet valve closes. At that point the piston is at a standstill, and inasmuch as its speed has been gradually reduced, it is natural to expect that the velocity of the air when started at a high rate is to a certain degree maintained, resulting in a completely filled air cylinder.

Table No. 5 gives the proportions of air cylinders, valves and clearance spaces in air compressors of the best modern design. In this case the inlet is concentrated; that is, the air is drawn into the cylinder through a piston inlet tube, hence five per cent. of the area of the cylinder is sufficient for the inlet. These dimensions have been practically tested, and in no case, even at the maximum speed of the machine, has there been any evidence of contraction.

TABLE NO. 5.—PROPORTIONS OF AIR CYLINDERS.

Sizes of Air Cylinders.	Per Ct. of Clearance. Free Air.	Per Ct. of Clearance Air Comp'd to 75 lbs.	Area of Cylinder. Sq. inch.	Air Inlet.			Air Discharge.		
				Size of Pipe.	Area of Pipe.	Per Ct. of Area.	No. of Valves	Area of Valves.	Per Ct. of Area.
10¼ in. x 12 in.	.0094	.047	78	2 in.	3.14	.04	2	5.4 sq. in.	.07
12¼ in. x 14 in.	.0086	.043	113	2½ in.	4.9	.043	2	8.8	.078
14¼ in. x 18 in.	.0066	.033	154	3 in.	7.	.045	3	13.2	.085
16¼ in. x 18 in.	.0066	.0330	201	3½ in.	9.6	.047	3	13.2	.065
18¼ in. x 24 in.	.0049	.0225	255	4 in.	13.	.051	8	35.2 sq. in.	.14
20¼ in. x 24 in.	.0049	.0225	314	4½ in.	16.	.051	8	35.2	.11
22¼ in. x 24 in.	.0049	.0225	380	5 in.	20.	.053	10	44.	.116
30¼ in. x 60 in.	.002	.01	707	6 in.	28	.04	18	79.2	.112
36¼ in. x 48 in.	.002	.01	1018	7 in.	38.5	.038	20	88.	.086

The clearance on the ends of cylinders is 1-16 inch on each end, and is the same on all cylinders, for pressures up to 100 lbs. On high pressure cylinders the end clearance is reduced to 0. The percentage of clearance at 75 lbs. is taken as 5 times free air, thus allowing heating.

The discharge valve area depends upon the speed of the compressor, and for the best results should be about ten per cent. of the cylinder area for a piston speed of 300 feet per minute, or fifteen per cent. for a speed of 450 or 500 feet.

W. L. SAUNDERS.

In the transcript of the remarks by the Editor of COMPRESSED AIR, at a recent meeting of the New York Railroad Club, an error is made in stating the advantages of cold intake air. The correct statement is that for every five *degrees* reduction in temperature of intake air we get about *one per cent.* larger *volume* delivered by compressor.

THE VALUE of Advertising in COMPRESSED AIR is being recognized by advertisers, because first of all it reaches people who are interested in new appliances, and this means the discarding of old ones and the purchase of new. Such a transaction reaches every avenue and artery of trade. Steam-engines, electric motors, water wheels, gas engines, first feel the pulsation and with them the thousands of other auxiliaries of the manufactory and machine shop. Almost every article that is used in the erection of plants can be profitably advertised here. It takes as many accessories to complete a compressed air plant as it does to tell the story of "The House that Jack Built."

Do not be too *exacting* in your limitations as to the proper article to advertise in its columns. It takes in a wide field.

NEW JERSEY'S HOPE FOR THE FUTURE.

COMMUNICATIONS.

Under this heading will be published inquiries addressed to the Editor of COMPRESSD AIR. We wish to encourage our readers in the practice of making inquiries and expressing opinions.

We request that the rules governing such correspondence will be observed, viz: all communications should be written on one side of the paper only: they should be short and to the point.

As an interested reader of your magazine, I find its terse and pithy articles have the effect of sharpening my appetite for more information concerning the subject of Air Power, which to the non-expert, like myself, is like an "undiscovered country." A host of questions arise in my mind, suggested by your magazine. But I venture now to ask one which is purely scientific and fundamental, viz: In compressing air, why is it that heat is generated, or, to put it conversely, why does the heating of air expand it?

Doubtless these questions may seem to you very simple, but I am free to admit, that while I have a theory about this matter, I cannot prove it scientifically.

NEW YORK. INQUIRER.

Our correspondent asks two questions—

1. Why is it that heat is generated? and
2. Why does this heating expand the air?

1. In compressing air, heat is produced because the piston does work upon the air which, being confined, does no work in return; hence there is a direct conversion of work into heat. We do not believe that there is any such *thing* as heat, but that what we call heat is the sensible effect of vibration. A moving piston, being the vibration of a mass, may be converted into moving molecules of air. Prof. Tyndall, in his book "Heat a Mode of Motion," illustrates the point by dropping a lead ball from the ceiling to an anvil on the floor, heat being produced and measured in the ball. "The motion of the lead," says Prof. Tyndall, "as a mass has been transferred to the atoms of the mass, producing among them the agitation we call heat." It is following this law of nature that heat

is produced when a target is struck by a shot. In the fire box of a locomotive we produce heat which is converted through the boiler to the engine and into the motion of the train. This motion may be converted back again into heat and the train brought to a standstill by friction in the axles, and this result is sometimes brought about by hot boxes on a train.

2. Heat expands air as it affects almost all bodies. It is supposed that this expansion is caused by the increased vibration acting to pull apart the atoms of the substance. It tends to destroy the cohesion in the particles.

EDITOR, COMPRESSED AIR,

Dear Sir :

Having been greatly interested in your series of articles on the development of the air compressor, I beg leave to call your attention to a few points in the article in the November number of your paper.

In the abstract of Mr. Darlington's test, the figures show an efficiency of compressions of 98.4 % $(\frac{37534}{38128})$ which is scarcely credible, as the resistance of the outlet valves alone will generally cause a greater loss than this.

It is a well known fact that indicator springs are temporarily weakened by heat and they are therefore adjusted under steam. As an instance of this fact, I recently tested a spring under steam pressure and found the scale to be 32.6. On allowing the indicator and testing drum to cool and then admitting compressed air, the scale was found to be 34. These figures were verified by three separate trials, the scale of the spring varying slightly at different pressures as is always found, but the comparative results remaining the same.

If Mr. Darlington did not calibrate his air compressor indicator springs with air, and his engine indicator springs with steam, his results are liable to an error of fully five per cent., and this error is in all probability the cause of the high efficiency of compression and the low efficiency of mechanism.

Further on the article reads as follows: "Hydraulic piston compressors are subject to the laws that govern piston pumps and are therefore limited to a piston speed of about 100 feet per minute. It is quite out of the question to run them at much higher speed than this without shock to the engine and fluctuations of air pressure." * * *

In the first place, modern practice for "piston pumps" of a size to be compared with air compressors is 250 feet per minute (see "Kent," page 605). I have lately seen a pump running at a piston speed of 300 feet a minute against a water pressure of 325 pounds, and have taken indicator cards from this pump showing entire abscence of injurious shock.

Also anyone can see in this country at a mine, the name of which I am not at liberty to mention, fully a thousand horse-power of hydraulic plunger compressors running at a piston speed of between 230 and 250 feet per minute, and running day and night, year in and year out, and the indicator cards are exceptionally good.

Yours truly,

CHARLES P. PAULDING.

EDITOR COMPRESSED AIR :

1.—If I compress air to 150 lbs. per inch in reservoir No. 1, and then cool it down with water to 35° f. h., and then recompress it to 200 lbs., and then expand it in my refrigerator, will it produce a greater degree of cold in the refrigerator than it would if I had compressed it to 200 lbs. in the first place and cooled it to 35°?

2.—What pressure do the street cars carry in your town?

3.—Is there any trouble with freezing of the valves in small compressed air engines?

4.—If compressed air is left a long while

in a tight reservoir does it lose any of its expansion force?

5.—Will the compressing cylinder get red hot if it has no water jacket?

6.—What per cent. of loss is there from the steam engine to the air motor, or how much less energy is there at the motor than at the engine that supplies the air?

7.—How many volumes of air have to be compressed into one to get 50 lbs. to the square inch?

8.—How high can water be raised with economy with air?

9.—Is it cheaper than pumps for a long lift?

10.—Does the higher pressure produce the most cold when expanded?

11.—Will an engine give as much power with air as steam at the same boiler pressure?

Please answer and oblige,

J. S. SHERMAN.

1.—No; the temperature at end of expansion depends upon the initial temperature and the number of expansions. In both cases you have the same initial pressure in your motor, and therefore can produce the same degree of expansion.

2.—Storage pressure of 2000 lbs. per square inch, and a working pressure ranging from 130 to 150 lbs.

3.—All trouble can be avoided by enlarging the exhaust opening. If the air is reheated before admission to motor, a low temperature at exhaust will be avoided and the efficiency will be increased (see COMPRESSED AIR, p. 71, No. 5).

4.—No.

5.—No; the theoretical temperature at end of compression without cooling for 60 lbs. gauge pressure, is 382° F.

6.—See articles in COMPRESSED AIR, page 89, No. 6, and page 13, No. 4, for full discussion on this point.

7.—4.4 volumes, for equal temperature compression.

8.—The highest practical lift made at present is 200 feet. Cases of still greater lift are on record.

9.—The Pohle air lift compares very favorably in economy with the direct acting pump.

10.—The higher the pressure the greater the expansion, and therefore the lower the temperature.

11.—If you mean that the initial pressure in the moter is to be the same in each case, and the air is to be used without reheating, then the steam will be more efficient as a fluid.

Compressed Air versus Trolley.

TO THE EDITOR—

In discussing the other day with a New York business man the advantages of the Compressed Air Motor over the Trolley, I referred to the safety of the former method and its freedom from delays and accidents. He asked me in a tone of triumph when I had ever heard of or seen any accident or delay caused by the Trolley?

I was surprised at this question, coming as it did from a man thoroughly well informed on current affairs, until I recalled the fact that he lived up-town in New York and had rarely "enjoyed" a ride on a trolley car. I am an unfortunate resident of trolley-ridden Brooklyn, and the very next day a practical answer was afforded me to his inquiry. While riding down Fulton Street on a car filled with passengers, we were all startled by a sharp explosion directly at the side of the car—and a heavy wire blazing and sputtering with blue-fire fell to the ground striking the end of the seats, directly in front of me.

The passengers jumped to the other side amid the screams of women, the shouts of men, while every face paled with fright and the stoutest men trembled with fear.

Of course the papers contained nothing of this for it was "only" a daily passing occurence, and my New York friend might say, "but no one was hurt." Apparently

not, and yet it is now conceded by the doctors, that such frequent shocks and frights, leads to prostrations and complications of the nervous system, oftentimes most serious.

Previous to this occurence I saw a live wire fall upon, and set fire to the roof of the car, and for a hundred feet along the street emitting flames for a minute or two —a menace to the lives of those crowding the busy thoroughfare.

The old saying you might as well kill a man outright, as to frighten him to death, might with a slight modification be aptly applied to the erratic and terrible Trolley.

Yours in the cause of public safety.

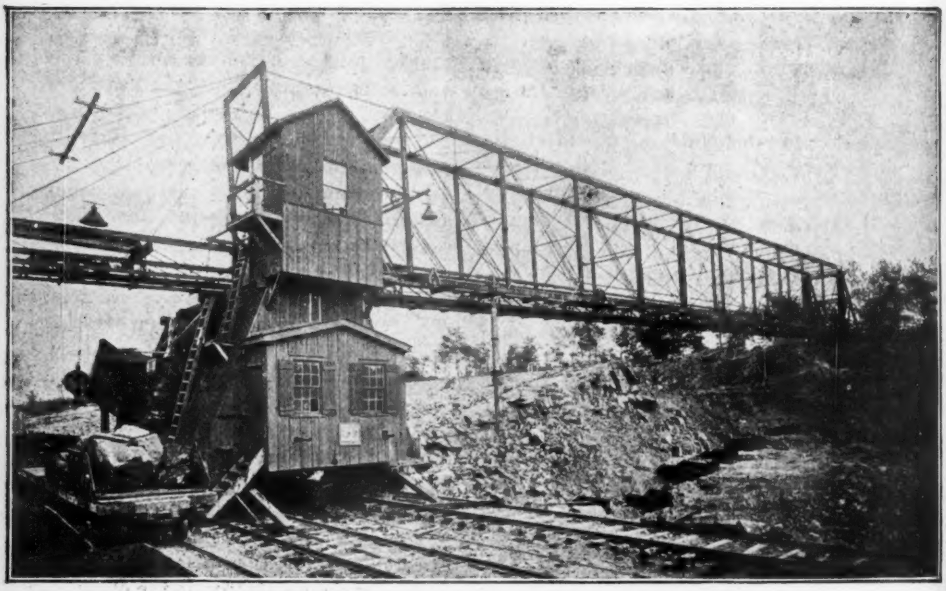
J. S. TOBEY.

BROOKLYN.

Mine Hoist.

The hoist below is one of Thos. A. Edison's devices used at the Ogden Mine at Edison, N. J.

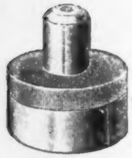
In the mine compressed air rock drills are used, and when the rock is finally broken and lies upon the bed, a bridge, which is poised transversely across the mine, and is fitted with crane and hoist appliances, is brought to a standstill over the rocks, that are often excavated in lumps weighing four tons (8,960 lbs.). These are chained, and a swinging compressed air hoist is attached. By the application of air to the cylinder, the rocks are rapidly elevated to where the skips lie, and in which they are placed.



COMPRESSED AIR OPEN CUT MINE HOIST.

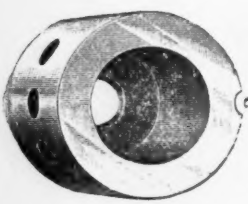
The swinging cylinder is the Compressed Air Hoist. Five of these hoists are along the rail of the bridge.

The Wolstencroft Pneumatic Tool Co., (Frankford) Philadelphia, Pa.



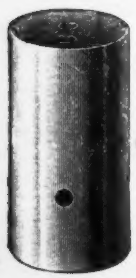
4

4—ANVIL



3

3—BUSHING

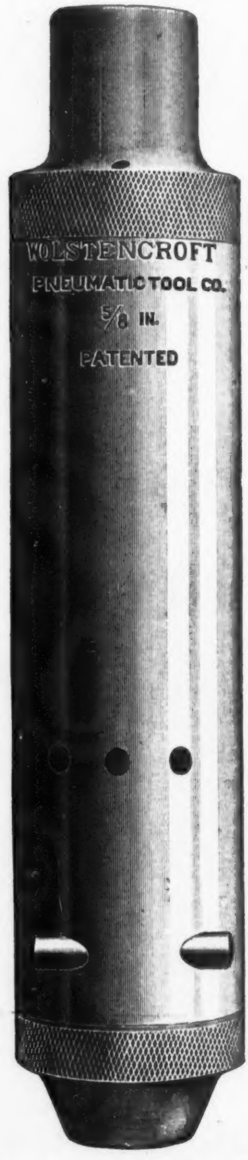


2

2—HAMMER

1

1—VALVE



The Simplest and Most Efficient Pneumatic Tool in the Market. Designed for caulking boilers, beading boiler flues and chipping metals of all kinds.

We are equipped to furnish an estimate on complete air plant as well as all sizes and kinds of pneumatic tools. Hammers from ¼ inch diameter, weight 93 grains, to 2 inch diameter, weighing 2½ lbs.

Efficiency Guaranteed for Five Years.